

PRAIRIE RESTORATION ACTION PLAN

George Washington Carver National Monument

1995

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## PRAIRIE RESTORATION ACTION PLAN

## George Washington Carver National Monument

## I. INTRODUCTION

## A. Historical mandate for prairie restoration

Prairie has long been an important element in the natural landscape surrounding what is now George Washington Carver National Monument. The park is located in north-central Newton County, an area of Missouri characterized by a mixture of elements of the Ozark Plateau and the Osage Plains. Presettlement prairie (roughly the first half of the 19th century) covered about 27% of the state of Missouri, including 27% of Newton County (Schroeder, 1982). In his 1823 survey of the western boundary of Missouri, Joseph Brown described the area as all prairie except for "very narrow strips of timber on the creeks" as far south as Shoal Creek in Jasper County. An 1882 county land survey of Newton County described the land as "undulating; even hilly in parts, consisting of nearly equal parts of timber and prairie." Figure 1 shows the presettlement prairie from Schroeder (1982).

The Moses Carver farm was located in what was a once vast prairie ecosystem called the Diamond Grove Prairie. Agricultural records for the 1850-1880 period show that the 240-acre farm had only 100 acres of improved land, with the remainder maintained as woodland and prairie (Jackson and Bensing, 1982; see Figure 2). Subsequent owners of the property, shortly after 1900, practiced more intensive uses of the land, resulting in a landscape much different from that which George Washington Carver observed while living here. In addition, land use permits for agricultural use were regularly issued from 1953 (the establishment of the park) until 1989. Uses included livestock grazing, hay production, and cropping. Cropping and grazing are no longer practiced at the park due to the lack of personnel and equipment needed to undertake such activities in a historically compatible way.

Among the guidelines outlined in the park's Master Plan (1965) were to "preserve natural features of this area, restoring conditions of 1860-1870 period to the extent feasible" and to plant other "vegetation as needed to restore the scene of Carver's boyhood". These goals have been supported in many subsequent

documents, such as the Resources Management Plan (1984), the Fire Management Plan (1984), the Statement for Interpretation (1993), and the Statement for Management (1992). A Cultural Landscape Report (CLR) is currently being undertaken at the park and will help refine our understanding of the historic period, including the location of prairie, woodlands, and crops.



## B. Present resource status

Currently, the park consists of about 130 acres of prairie in various stages of restoration as directed by the Prairie Action Plan (1984). In addition to developed areas for visitor use (manicured lawns, picnic grounds, buildings, and paved areas), the remainder of the park is riparian woodland. Figure 3 shows the most recent map of the park, showing prairie versus woodland. A study by Jackson (1985) involved extensive quantitative surveys of six areas of the prairie no longer under historic lease. This was the only quantitative information collected on any of the restoration areas prior to restoration work (the areas still under historic lease at that time were not surveyed).

A large variety of plants and animals occur in the park. A survey by Ernest Palmer (1983) identified more than 500 species of plants in the park, samples of which were donated to the park's collection. Other plant and animal groups have been the subject of various student surveys by Missouri Southern State College, but the park is very much in need of adequate baseline data on all fauna and flora, including the species and composition of the prairie units.

A survey conducted in 1981 by Benn documented ten archaeological sites (Benn, 1982). In addition, the park protects and maintains five historical structures, the 1881 Moses Carver House, the Carver Bust, the Dedication Plaque, the Boy Carver Statue, and the Carver Family Cemetery. Other historic concerns are the walnut fence rows, the persimmon grove, and historic roads and trails. Figure 4 shows the locations of the archeological sites and historic structures.

The Diamond Grove Prairie, located about 5 miles northwest of the monument in Newton County, is a 510 acre wildlife area managed by the Missouri Department of Conservation. It was historically part of a larger prairie ecosystem that once included the prairies at the monument. Due to its use history and careful protection, Diamond Grove exhibits the best nearby example of southwestern Missouri tallgrass prairie. Thus, it is well-suited as a model from which to formulate restoration goals at George Washington Carver. Monitoring of the George Washington Carver and Diamond Grove prairies was conducted in the summer and fall, respectively, of 1993. Analysis of the species coverage and diversity data for

both areas will allow continual comparison between the monument's prairies and those at Diamond Grove.





### C. Prairie restoration status

In 1981, the park began a restoration program, beginning with an initial baseline monitoring study. Then, 6 units were placed into a cycle of various restoration practices such as plowing, disking, seeding with native grass and forbs, mowing, and prescribed burning. Management actions were guided by an ongoing study by Jackson, who produced information about the present state of the prairie units and offered management recommendations (Jackson, 1985). A Prairie Action Plan was developed in 1984. Practices continued through 1994 under the guidance of the 1984 Plan.

The division of the park's open areas into 15 units was a holdover from the leasing program (see Figure 5). Grazing leases in the park were discontinued in 1983; agricultural leases in 1989. Other units were added to the restoration program as the leases were phased out, with unit configurations gradually changing. By 1989, a new prairie unit map was developed, dividing the prairie into 7 units (and one subunit). This configuration will be used for future prairie management, with the addition of Unit 8 (as discussed below). A summary of prairie management actions from 1982 through 1994 is enclosed in Appendix II.

### D. The purpose of this plan

The purpose of the Prairie Restoration Action Plan is to guide the continuing restoration of a representation of the prairie scene of the 1860-1870 period of young George Washington Carver. This management approach retains the openness of the prairie areas and emphasizes the natural setting that was a strong part of Carver's early life. The Plan updates and incorporates methods in the 1984 Plan, and includes an analysis of the current status of the prairie units, a set of qualitative and quantitative goals for restoration, and methods for monitoring to collect baseline data and measure restoration success.

## II. DETAILED DESCRIPTION OF HISTORIC RESOURCES

### A. Physical setting

#### 1. Climate

Climatological summaries available for Springfield show the mean annual temperature for southwest Missouri as 56°F, with a mean of 40 inches of precipitation. Appendix IX shows the monthly temperature and precipitation averages. Prevailing winds are from the south-southeast. The region is typified by hot summers and cold winters, with severe weather possible throughout the year, particularly during spring and summer. Precipitation is distributed rather evenly throughout the year, ranging from an average of 4.8 inches in June to 1.5 inches in January.

#### 2. Topography/hydrology

The park consists of gently sloping topography, with a vertical relief of approximately 40 feet. Elevations range from 1080 feet in the east-central portion of the monument to around 1040 feet in the west-central portion. Several portions of the park have a high water table, resulting in many areas of seeps and standing water during wet periods (see Figure 6). The park receives runoff from lands adjacent on the north and east. Several springs originate in the park, and two streams, Carver Branch and Harkins Branch, flow through. A third stream, Williams Branch, originates as a spring in what is now a half-acre pond and then flows a short distance to join Carver Branch.

#### 3. Soils

Soils are generally of the Hoberg-Keeno association, typified by gentle, rolling topography and fairly coarse, upland soils (Newton County Soil Survey). Figure 7 shows an extrapolation of the county soil survey map for the park as shown in Jackson (1985). Existing park soils have the potential to support prairie vegetation, since the native vegetation for these types of soils is usually prairie. This includes the Secesh-Cedargap complex that underlies much of the woodland portion of the park. In his study, Jackson measured the change in soil cation exchange capacity, neutral acidity, organic matter, magnesium, calcium, potassium, phosphorus, and pH in units 1-6 from 1982 to 1985. His

conclusion was that the changes in these parameters over time were positive and, regardless of whether they were a direct result of the restoration practices or a natural progression, the soils were apparently improved.

## B. Vegetation

### 1. Description of the historic scene vegetation

The prairie of the 1860-1870 historic scene consisted of "unimproved" tracts as well as "pasture" on the Moses Carver farm. The original Diamond Grove prairie, which once extended over a large portion of north-central Newton and south-central Jasper counties (see Figure 1), is best preserved in Diamond Grove Prairie Wildlife Area, five miles northwest of the park. Administered by the Missouri Department of Conservation, this 570 acre prairie contains a wide diversity of flora and fauna. Soils and topography are similar to those found at the park. Diamond Grove will serve as a model for qualitative and quantitative comparison.

### 2. Historic accounts of vegetation

Use of the term "prairie" in many early land surveys is often open to interpretation (Schroeder, 1982), but the earliest land surveys of Newton County, 1846 and 1882, provide fairly good, general assessments of the vegetation (Figure 2). As reflected in Jackson and Bensing (1982), very little additional data exists to offer clues as to the areal extent and species composition of the historic scene prairie. Therefore, determining the historical model on which to base restoration at the park requires a determination of these two factors.

### 3. Agricultural history

Jackson and Bensing (1982) present an extensive study of the land use patterns over the history of the Carver farm. Apparently, cultivation on the farm consisted of fairly small crop fields (i.e. less than 50 acres each). The Carvers managed a fairly diverse agricultural operation, raising horses, cattle, swine, sheep, goats, and poultry, as well as small-scale cropping and

even an orchard of as many as 520 trees (Toogood, 1973). Federal census records from the period 1850-1880 show that Moses Carver raised Indian corn, wheat, oats, Irish potatoes, and hay crops. The cash value of Carver's farm was "above most of the 64 farms listed in the township" (Toogood, 1973).

Post-Carver owners reduced this diversity and alternated large-scale livestock grazing and cropping. Cropping and grazing continued, after the establishment of the park, first under the Agricultural Lease program, and then under the Historic Lease program. Many of the units were either cropped, grazed, and/or planted and cultivated for hay until as late as 1989. A detailed description of land uses for each unit is discussed in section IIIB. Detailed grazing/cropping records, if kept at the time, do not exist. A Memorandum of Understanding with the Newton County 4-H, dated 7/11/1990, has permitted haying in selected prairie units under a renewable five-year plan. This agreement will be renewed in 1995. Compatible with the prairie management plan, the haying (although not conducted annually) serves an important role in the management cycle of the prairie, in turn providing hay to a local organization.

#### 4. Evidence of historic vegetation from current vegetation

A comprehensive vascular plant survey, including an inventory of woody plants in the woodland subzone, is necessary to determine the plant species composition in the park. Jackson (1985) indicates that what is now Unit 1 may be the closest in species composition to original native prairie, due to its apparently limited history of land use. This may be compared to many other prairie remnants that survived in many areas of the state along fencerows, field corners, and other tracts left undeveloped due to their small size, difficulty of access, and/or by chance of geometric arrangement. Portions of Units 3 and 4 also may have compositional elements surviving from the historic period.

Species composition studies done at Diamond Grove Prairie (Solecki et al, 1986) show a wide diversity of prairie species. Diamond Grove has a long history of grazing and hay production, which may have led to some changes in species composition. However, the Diamond Grove prairie has never been plowed or planted to crops. Consequently, its species composition is much closer to a natural prairie ecosystem than any area at the park.

## 5. Historic importance of fire

Little is known about the fire history of the region that includes George W. Carver National Monument. However, numerous sources cited by Ladd (1991) leave a collective body of evidence that fires were frequent during the pre-settlement era in much of Missouri. Those mentioned were fires set annually by native people to clear areas of heavy forest, to maintain a diversity of plants (and, thus, animal species), and to reduce the threat of catastrophic fires within the very resources on which they depended for existence. Although Ladd's paper was specifically about oak woodlands (and woodlands in general), the frequent mention of "prairie" in these early accounts of set fires, and the apparent widespread nature of the fires, suggests that it is reasonable to assume that these fires were occurring in our area as well.

In another study by Guyette and McGinnes (1982), tree ring analysis of eastern redcedar on glades near Ava, Missouri showed that fires were present every 3.2 years during presettlement times (before 1879). Fire frequency dropped off markedly afterwards, to every 22 years. In short, this study stated that "man was probably the most important ignition source during non-drought years". It is important to note that these findings do not reflect "low-intensity fires that do not result in scar formation" (Ladd, 1991).

## C. Cultural resources

### 1. Archaeological sites inventory as it relates to restoration

An archaeological overview is needed for the park, as discussed in the Resources Management Plan (1993). The ten sites documented by Benn (1982; see Figure 4), are mostly of post-settlement origin. The birthplace (23 NE 119), Gilmore (23 NE 120), Williams (23 NE 121), and Carver house (23 NE 167) sites, along with sites 23 NE 163, 23 NE 164, 23 NE 166, and 23 NE 122, are located within the woodland subzone. Archaeological evidence may extend into prairie Unit 7 from the Carver house site, and an artifact find, 23 NE 165 (find spots A and B) is located in the north end of Unit 5. No other sites are known to exist in the prairie units.

Early prairie restoration practices included plowing and disking in some areas. At present, none of the prairie units are in a condition where soil turnover is needed for grass planting. Light disking (i.e. a few inches of topsoil) may be necessary in some areas with heavy vegetative cover to provide a seed bed for planting forbs.

## 2. Other archaeological/cultural concerns

Pending a Cultural Landscape Report (CLR), the park has a limited understanding of the historic scene. A report by Jackson and Bensing (1982) provided a map of the area during the period of the Moses Carver farm based on historical references, county atlas maps, and old aerial photographs. From this study, is it apparent that cultural features such as roads, trails, fence rows, and other features once lay under what is now prairie. After the completion of the CLR, the park will have the guidance for which to reestablish such features, should they be determined necessary and feasible.

## III. DETAILED DESCRIPTION OF CURRENT VEGETATION

## A. Forest

Studies by Jackson (1985) suggest that 40 years ago the woodlands were restricted to within 10 feet of the streams. After the dedication of the park, the forests have been allowed to invade portions of the prairies. This configuration was apparently also true of the 1860-1870 historic scene (Jackson, 1985). A general assessment of the current species composition of the woodland subzone reflects some type of disturbance, most likely grazing, selective cutting, and/or plowing. The dominant species include black walnut (*Juglans nigra*), American elm (*Ulmus americana*), osage orange (*Maclura pomifera*), and hackberry (*Celtis occidentalis*), with lesser amounts of black cherry (*Prunus serotina*), red mulberry (*Morus rubra*), bur oak (*Quercus macrocarpa*), slippery elm (*Ulmus rubra*), and ash (*Fraxinus pennsylvanica*).

Benn (1982) points out that the composition of riparian forest in the region reflected an oak/hickory association of species such as bitternut hickory (*Carya cordifolius*), shagbark hickory (*Carya ovata*), white oak (*Quercus alba*), red oak (*Quercus rubra*), and black oak (*Quercus velutina*). Secondary species which may have been present were pignut hickory (*Carya glabra*), black walnut (*Juglans nigra*), black cherry (*Prunus serotina*) and American basswood (*Tilia americana*). The present composition is indicative of a lowland early successional community of such an association.

An important issue in the restoration of the prairie is the forest/

prairie ratio of the 1860-1870 historic scene. The completion of a CLR, as noted above, is necessary to better determine the size and configuration of these two ecosystems. Only then will it be possible to adequately assess the woodland subzone and the need for restoration to a better representation of the historic period.

Until then, prairie restoration will continue within the areal parameters set forth by the 1984 Action Plan.

## B. Prairie



Changes in vegetative composition have occurred over time as changes occurred in land ownership, though no quantitative data was collected prior to 1981 (Jackson and Bensing, 1982) to adequately describe these changes. As we have seen, agricultural uses have been quite varied, and the advent of National Park Service ownership resulted in additional changes to the prairie. Land use histories of the prairie areas have been described by Jackson and Bensing (1982), Jackson (1985), and Toogood (1973).

A monitoring study prepared by Wilson and Jackson (1994), provided a good summary of the current state of the prairie units. All species found in plots were quantified. In addition, five target species that include both desirable prairie species and undesirable exotic species were mapped in eight units. Cluster analysis was completed to compare species composition between the park's prairies and to prairies at Diamond Grove Prairie. This showed that units 3, 5, 6, and 7 show similarity and can be described as "immature prairie". Units 1, 2, and 4 have the greatest similarity to each other and to Diamond Grove, and can be described as "moderately mature prairie". Unit 7B showed the least similarity to all of the units (including Diamond Grove), and can be described as "disturbed prairie". This study also provided a comparison between monitoring results in 1981 and 1993.

Although studies by both Palmer (1983) and Jackson (1985) demonstrated that prairie remnants, or at least species representative of prairie, existed in the park prior to restoration activities in the early 1980s, the current species composition in all of the prairie units strongly reflects the restoration actions. In fact, many species were planted that were erroneously thought to be important species for the park, or were planted at seeding rates much higher than are reflected at prairies in the park's region.

For example, species such as switchgrass and side-oats grama, which are present in much lower rates of cover at Diamond Grove prairie, are now abundant at the park due to grass seeding practices that were used as late as 1992. In addition, cover values and composition in all of the units reflect an overabundance of exotic species.

The following is a summary of land use and species composition for each unit (see also Appendix II). Descriptions of unit needs are discussed later in the Restoration Goals section. Also included

is a table showing the ten most dominant species in each unit, by order of the highest importance values (from Wilson and Jackson, 1994), based on 1993 monitoring (methods are described in Appendix III). Wherever possible, values from the initial prairie study for units 1-4 (respectively) are included in a separate table for comparison (Jackson and Bensing, 1982). Importance values (from 1993) were derived from averaging the values of relative frequency and relative cover, respectively, and are based on a compilation of both summer and fall monitoring results. In each unit, qualitative comparisons are also made to the Diamond Grove model (section IIIC). Coefficient of Conservatism values, derived from a list prepared from the Missouri Nature Conservancy (see Appendix V), are included to provide a measure of the species' importance to the natural community, with more conservative (i.e. more naturally-occurring) species with the higher numbers. Species marked with an asterisk (\*) denote adventives.

## 1. Unit 1

This is also known in old maps as Unit 1. It may contain remnants of relatively undisturbed prairie, and shows a high diversity of native grass and forb species, with considerable amounts of woody species in the western half and scattered exotic grasses and weeds. A small drainage ditch runs northwesterly through the northeast corner of the unit, and an associated stream terrace runs diagonally through most of the unit. Soils include the Keeno and Secesh-Cedargap series.

Studies of aerial photographs and land use permits show that, at least during the history of the park, the only use for the area was grazing and haying. Grazing was discontinued after 1983. Some planting of forbs and grasses was conducted after restoration began, and the unit has become part of the haying cycle under the 4-H Memorandum. Species importance value comparisons between 1981 and 1993 show that the unit has progressed in that time from an early successional, weedy area to a community dominated by many prairie species. The 1993 values also reflect an overabundance of some native species (*Panicum virgatum* and *Rubus pensylvanicus*) due to planting.

## Dominant Species in Unit 1 (1981)

Species	Coeff.	Importance	Value
	of Cons.		
<i>Cerastium vulgatum</i>	*		82
<i>Andropogon virginicus</i>	2		52
<i>Andropogon gerardii</i>	5		52
<i>Festuca arundinacea</i>	*		42
<i>Tridens flavus</i>	1	38	
<i>Rubus, sp.</i>	-		27
<i>Paspalum laeve</i>	2	18	
<i>Oxalis stricta</i>	0		18
<i>Euphorbia dentata</i>	0		18

## Dominant Species in Unit 1 (1993)

Species	Coeff.	Freq.	Cover	Importance	Value
	of Cons.				
<i>Sorghastrum nutans</i>	5	.50		23.49	.097
<i>Panicum virgatum</i>	4	.31		22.69	.071
<i>Andropogon gerardii</i>	5	.23		24.18	.061
<i>Rubus pensylvanicus</i>	2	.33		5.29	.052
<i>Sporobolus asper</i>	4	.01		37.50	.048
<i>Coronilla varia</i>	*	.01		37.50	.047
<i>Phleum pratense</i>	*	.01		37.50	.047
<i>Andropogon scoparius</i>	5	.07		23.50	.038
<i>Panicum anceps</i>	2	.12		16.43	.037
<i>Bromus sterilis</i>	*	.03		25.90	.036

Total species (1993): 147; grass/sedges=38 (26%); woody=16 (11%); forbs=93 (63%); total exotic species: 34 (23%)

The next ten species, in order of importance value (1993): *Rudbeckia hirta*, *Croton glandulosus*, *Desmodium canescens*, *Lysimachia ciliata*, *Bromus secalinus*, *Tridens flavus*, *Rubus trivialis*, *Setaria faberii*, *Poa annua*, and *Erigeron philadelphicus*.

## 2. Unit 2

Known on old maps also as Unit 2, this area was under tillage at various times earlier in the century, but is especially notable for heavy grazing both before and after the establishment of the park. Grazing was discontinued after 1981, and restoration continued thereafter. It is a nearly level, dry unit, made up entirely of Secesh-cedargap soils. It currently exhibits a strong diversity and cover of native warm-season grass and a low occurrence of native forbs. Undesirable exotics are not present in large numbers, as 1981 monitoring results revealed, suggesting that this unit has been improved in terms of overall native grass cover, but species such as *Panicum virgatum* and *Bouteloua curtipendula* are now overabundant due to planting.

## Dominant Species in Unit 2 (1981)

Species	Coeff.	Importance	Value
	of Cons.		
<i>Festuca arundinacea</i>	*		77
<i>Cerastium vulgatum</i>	*		64
<i>Paspalum ciliatif.</i>	3		40
<i>Oxalis stricta</i>	0		38
<i>Eleusine indica</i>	*	37	
<i>Paspalum laeve</i>	2		26
<i>Eragrostis</i> , sp. -		21	
<i>Taraxacum officinale</i>	*		19
<i>Tridens flavus</i>	1		15
<i>Carex</i> , sp. -		13	

## Dominant Species in Unit 2 (1993)

Species	Coeff.	Freq.	Cover	Importance
	of Cons.			Value
<i>Sorghastrum nutans</i>	5	.96	19.04	.145
<i>Panicum virgatum</i>	4	.64	40.37	.142
<i>Andropogon gerardii</i>	5	.73	27.12	.140
<i>Andropogon scoparius</i>	5	.53	26.98	.119
<i>Festuca arundinacea</i>	*	.51	27.71	.104
<i>Bromus sterilis</i>	*	.05	22.17	.059
<i>Poa annua</i>	*	.15	14.22	.043
<i>Tridens flavus</i>	1	.16	10.50	.042
<i>Bouteloua curtipend.</i>	7	.07	14.12	.041
<i>Agrostis hyemalis</i>	3	.30	5.53	.040

Total species (1993): 79; grass/sedges=32 (41%); woody=5 (6%); forbs=42 (53%); total exotic species: 17 (22%)

The next ten species, in order of importance value (1993): *Cyperus strigosus*, *Medicago lupulina*, *Verbesina virginica*, *Paspalum setaceum*, *Fimbristylis autumnalis*, *Erigeron strigosus*, *Rubus pensylvanicus*, *Dichanthelium oligosanthes*, *Festuca octoflora*, and *Rudbeckia hirta*.

### 3. Unit 3

Known on old maps as Unit 3, but at various times divided into 3 (western two-thirds) and 3B (eastern one-third), this unit has a diverse history. The western third or so is sloping and rocky. Until the late 1970s, it was essentially little used and was overgrown with trees and shrubs. Most of the trees were then removed. The eastern two-thirds has been under cultivation throughout much of the post-settlement period, a practice that continued in various forms until as late as 1989. Crops included corn, oats, and hay grazer (sorghum), and some fescue was seeded during the mid-1960s. Grazing was practiced in the unit, alternating with cropping, until 1983. Native grass was planted in 1990, and the eastern two-thirds was hayed in 1992. Soils include Keeno (on the higher and sloping portions in the west), Wanda (most of the eastern, more hydric areas), and Carytown (the extreme southeast corner - hydric).

Monitoring in 1993 showed that, overall, the unit has a large diversity of species, but that native desirables are sparsely distributed and that undesirables are common throughout. One exception, switchgrass, is over-abundant in the east portion. A comparison to monitoring results in 1981 shows an increase in quantities of native grasses due to planting, but that large amounts of exotic species are still present. Currently, the eastern portion contains a large stand of switchgrass and a few other native grasses, with very few forbs. The western portion has a fairly diverse native flora, but has a large amount of woody shrubs and weeds.

## Dominant Species in Unit 3 (1981)

Species	Coeff. Importance of Cons.	Value
<i>Andropogon virginicus</i>	2	82
<i>Festuca arundinacea</i>	*	68
<i>Tridens flavus</i>	1	45
<i>Muhlenbergia schreberi</i>	0	38
<i>Ambrosia artemisiifolia</i>	0	27
<i>Setaria glauca</i>	*	19
<i>Oxalis stricta</i>	0	17
<i>Trifolium repens</i>	*	8
<i>Paspalum laeve</i>	2	7.6
<i>Ulmus, spp.</i>	-	7.6

## Dominant Species in Unit 3 (1993)

Species	Coeff. of Cons.	Freq. Cover	Importance Value
<i>Panicum virgatum</i>	4	.46	36.59.053
<i>Poa annua</i>	*	.19	46.52.047
<i>Bromus secalinus</i>	*	.22	40.17.044
<i>Bromus sterilis</i>	*	.03	50.62.040
<i>Festuca arundinacea</i>	*	.11	40.68.038
<i>Aster pilosus</i>	0	.40	8.14.032
<i>Agrostis hyemalis</i>	.39	14.18	.032
<i>Rubus pensylvanicus</i>	2	.36	15.38.032
<i>Sporobolus neglectus</i>	3	.02	38.75.030
<i>Sorghastrum nutans</i>	5	.25	16.42.029

Total species (1993): 169; grass/sedges=44 (26%); woody=28 (17%);  
forbs=97 (57%); total exotic species: 35 (21%)

The next ten species, in order of importance value (1993):  
*Rudbeckia hirta*, *Lespedeza virginica*, *Andropogon scoparius*,  
*Erigeron strigosus*, *Bouteloua curtipendula*, *Panicum capillare*,  
*Eragrostis spectabilis*, *Rubus pensylvanicus*, *Cyperus ovularis*, and  
*Rudbeckia hirta*.



## 4. Unit 4

Incorporating old Units 4 (north of the Carver Trail) and 5 (south of the Carver Trail), most of what is now Unit 4 was not part of the leasing program. There is evidence that some remnants of native prairie may have survived over the years. The northern and southernmost portions were used for grazing and cropping at various times, but the history of the unit during park ownership shows that it has suffered comparatively little impact. Restoration actions, including seeding, mowing, haying, and prescribed burning, were begun in 1981. The unit is gently sloping, with little or no areas of poor drainage. Soils are almost exclusively of the Keeno series, with small amounts of Wanda (in the far western portions) and Hoberg (far eastern) soils.

Monitoring in 1993 showed that native components dominate the unit, in contrast to 1981 results showing weedy plants dominating.

Native forbs are also fairly diverse due to seeding, so this is one of the best examples of tallgrass prairie in the park. Significant amounts of *Vitis aestivalis*, *Rhus copallina*, fescue, and bluegrass occur in many portions, and the unit has expanded over the years due to the narrowing of the Carver Trail and the mowed area by the Visitor Center. Switchgrass (*Panicum virgatum*) is overabundant in many portions, forming dense stands. This unit was burned in April, 1994, revealing that a considerable amount of woody species were present throughout (a visual inspection of the unit during the summer that year showed that quantities were not reduced by burning). A narrow strip of land along the western portion of the unit (just west of the trail and walnut row) was labelled Unit 6 for Jackson's study. It is now unit 4A, and exhibits a good mix of a variety of native grasses and forbs.

## Dominant Species in Unit 4, north (1981)

Species	Coff.	Importance	Value
	of Cons.		
<i>Poa pratensis</i>	*		100
<i>Panicum virgatum</i>	4		62
<i>Cerastium vulgatum</i>	*		44
<i>Festuca arundinacea</i>	*		31
<i>Tridens flavus</i>	1		28

Setaria glauca	*	23
Tragopogon dubius	*	22
Oxalis stricta	0	20
Croton monanthogynous	2	19
Lactuca seriola	*	18

Dominant Species in Unit 4, south (1981)

Species	Coff. Importance of Cons.	Value
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Chrysopsis pilosa	3	79
Andropogon virginicus	2	65
Panicum virgatum	4	56
Andropogon gerardii	5	38
Muhlenbergia schreberi	0	37
Tridens flavus	1	36
Poa pratensis	*	35
Hieracium pratense	-	25
Rhus glabra	2	24
Euphorbia dentata	0	21

Dominant Species in Unit 4 (1993)

Species	Coeff. of Cons.	Freq. Cover	Importance Value
Panicum virgatum	4	.80	37.63.095
Festuca arundinacea	*	.03	61.67.056
Vitis aestivalis	5	.01	62.50.056
Andropogon scoparius	5	.52	16.97.054
Sorghastrum nutans	5	.63	10.27.053
Andropogon gerardii	5	.40	21.93.051
Sporobolus neglectus	3	.34	30.41.051
Panicum anceps	2	.50	9.03.043
Bouteloua curtipend.	7	.29	23.69.041
Rhus copallina	2	.26	16.39.035

Total species (1993): 135; grass/sedges=40 (30%); woody=18 (13%); forbs=77 (57%); total exotic species: 27 (20%)

The next ten species, in order of importance value (1993): *Muhlenbergia schreberi*, *Poa annua*, *Dactylis glomerata*, *Bromus sterilis*, *Paspalum publiflorum*, *Rhus glabra*, *Tridens flavus*, *Lespedeza capitata*, *Solanum carolinense*, and *Rudbeckia hirta*.

## 5. Unit 5

This large unit was once divided up into Units 8, 12, 13, and 14.

Unit 12 was essentially what is now the southern half of Unit 5, with the exception of the extreme southwestern corner (old Unit 8). Because of the numerous unit designations, the area has a varied history. The old units were some of the last to be removed from the lease program. Various crops, including corn, winter wheat, and hay grazer (sorghum) were grown in the north half (Units 13 and 14). The southern half was used for both grazing and cropping. Grazing was last conducted in 1983; cropping in 1989.

The unit was planted with native grasses in 1991 (southwest corner), 1992 (the north half and southeast corner), and 1993 (portions of the southern half). Although 1993 monitoring showed that weedy species are widespread and abundant, there is currently a good mix of planted native grasses in the northernmost portion, with an overabundance of *Panicum virgatum* (though the diversity and cover of these decrease further south). The south-central portion has a vigorous stand of red clover (*Trifolium pratense*). The southwestern portion, normally very wet during the winter and spring, is characterized by hydric species such as *Carex*, sp. and *Cyperus*, sp. The southeastern portion is also very weedy, but some plant native grass does occur in places. Very low native forb diversity is evident in the entire unit.

The unit slopes gradually from northeast to southwest. Soils are quite variable and include Keeno (much of the central and southeastern portions), Hoberg (most of the northern and east central portions), Wanda (portions of the south-central and southwest), and Carytown (much of the southwest corner).

## Dominant Species in Unit 5 (1993)

Species	Coeff. of Cons.	Freq.	Cover	Importance	Value
<i>Bouteloua curtipend.</i>	7	.47	37.58	.063	
<i>Festuca arundinacea</i>	*	.16	42.43	.047	
<i>Bromus secalinus</i>	*	.43	22.51	.046	
<i>Croton glandulosus</i>	1	.62	1.81	.041	
<i>Setaria faberi</i>	*	.34	19.07	.038	
<i>Carex shortiana</i>	4	.02	41.12	.037	
<i>Toxicodendron radicans</i> , var. <i>negundo</i>	1	.01	50.00	.037	
<i>Aster pilosus</i>	0	.47	5.14	.034	
<i>Trifolium pratense</i>	*	.17	29.22	.033	
<i>Panicum virgatum</i>	4	.23	18.64	.029	

Total species (1993): 153 (grass/sedges=46; woody=12;  
forbs=95); total exotic species: 42 (27%)

The next ten species, in order of importance value (1993):  
*Hordeum pusillum*, *Eleocharis obtusa*, *Andropogon gerardii*, *Bromus sterilis*, *Sporobolus neglecta*, *Digitaria sanguinalis*, *Medicago lupulina*, *Poa annua*, *Andropogon scoparius*, and *Solanum carolinense*.

## 6. Unit 6

Formerly known as Unit 10, this portion of the park has been extensively used as both pasture and cropland. Grazing was last conducted in 1981; cropping (including clover, hay-grazer, corn, and soybeans) in 1989. A low, wet unit, the soils include mostly Carytown and smaller amounts of Secesh-Cedargap (in the northernmost portions) and Wanda (southern portions of the unit). It was disked and planted with native grass in 1991, and a good cover and diversity of native grass is currently present, with the wetter areas containing stands of hydric species such as *Carex*, sp. and *Cyperus*, sp. Monitoring in 1993 showed a substantial amount of exotic weeds occurring throughout. Comparatively few native forbs are present.

## Dominant Species in Unit 6 (1993)

Species	Coeff. of Cons.	Freq.	Cover	Importance Value
<i>Bromus secalinus</i>	*	.56	23.50	.063
<i>Agrostis hyemalis</i> 3	.57	17.79	.058	
<i>Ambrosia trifida</i>	0	.01	62.50	.057
<i>Tridens strictus</i>	5	.02	61.67	.057
<i>Festuca arundinacea</i>	*	.06	56.94	.056
<i>Andropogon gerardii</i>	5	.37	21.91	.052
<i>Erigeron strigosus</i>	3	.57	10.42	.051
<i>Solanum carolinense</i>	0	.55	1.92	.050
<i>Bouteloua curtipend.</i>	7	.36	19.14	.049
<i>Croton glandulosus</i>	1	.42	7.76	.044

Total species (1993): 120 (grass/sedges=36; woody=7; forbs=77); total exotic species: 35 (29%)

The next ten species, in order of importance value (1993): *Sorghastrum nutans*, *Aster pilosus*, *Panicum virgatum*, *Andropogon scoparius*, *Melilotus officinalis*, *Melilotus alba*, *Dactylis glomerata*, *Festuca arundinacea*, *Panicum capillare*, and *Bromus secalinus*.

## 7. Unit 7

Made up of what was formerly Units 7, 9, and 11, this area also has a varied history. All portions were used for both cropping and grazing both before and after the establishment of the park. Crops were grown in the western and eastern portions as late as 1989. Grazing was discontinued after 1983. Winter wheat, corn, hay-grazer, orchardgrass/fescue, and soybeans were all grown during its lease period. Restoration was begun in 1990 with the planting of native grasses in the western and southeastern portions, in 1992 in all but the southeastern portion, and in 1993 in the southeast. There is currently a good diversity and cover of native grass in the western portion. The northeastern portion is mixed with native grass and a large amount of weeds, and the southeastern portion has large stands of switchgrass scattered loosely throughout, with scattered stands of other native grass. There are few native forbs in any part of the unit.

The southwestern and southeastern portions of the unit are hydric and rather poorly drained. Soils in the unit include Keeno (most of the north-central and northeastern portions), Wanda (the west-central and southeastern-most areas), Secesh-Cedargap (northwest), and Carytown (much of the southwestern portion).

## Dominant Species in Unit 7 (1993)

Species	Coeff. of Cons.	Freq.	Cover	Importance	Value
<i>Panicum virgatum</i>	4	.57	37.17	.061	
<i>Festuca arundinacea</i>	*	.01	50.00	.056	
<i>Bouteloua curtipend.</i>	7	.35	22.26	.049	
<i>Andropogon scoparius</i>	5	.43	14.84	.047	
<i>Setaria faberi</i>	*	.37	15.06	.042	
<i>Dichanthelium oligo.</i>	3	.08	33.64	.042	
<i>Croton glandulosus</i>	1	.53	3.50	.041	
<i>Sorghastrum nutans</i>	5	.46	7.40	.040	
<i>Digitaria sanguinalis</i>	*	.25	17.68	.037	
<i>Solanum carolinense</i>	0	.50	3.07	.035	

Total species (1993): 130 (grass/sedges=41; woody=16; forbs=73); total exotic species: 42 (32%)

The next ten species, in order of importance value (1993): *Setaria glauca*, *Aster pilosus*, *Panicum capillare*, *Bromus sterilis*, *Andropogon gerardii*, *Erigeron strigosus*, *Salix nigra*, *Verbena canadensis*, *Rubus pensylvanicus*, and *Conyza ramosissima*.



Three other areas of unit 7 will be considered separately for the purposes of this plan.

a. Unit 7A includes a mix of woodland and clearings between the southeast portion of unit 7 proper and Carver branch. It is essentially prairie overgrown with small trees and many exotic and weedy plants. This area has never been monitored for species composition.

b. Unit 7B is situated south of Carver Branch between the stream and the picnic area. A walnut fence row (the origin of which is uncertain) is located east/west across the unit. Monitoring was conducted in this unit in 1993. It exhibits almost no prairie elements, and will be used as a demonstration prairie/savannah in the effort to restore it (see Demonstration Prairie Plan, Appendix IV).

#### Dominant Species in Unit 7B (1993)

Species	Coeff. of Cons.	Freq.	Cover	Importance Value
<i>Festuca arundinacea</i>	*	.51	41.38	.105
<i>Muhlenbergia schreb.</i>	0	.61	34.67	.103
<i>Bromus sterilis</i>	*	.38	27.64	.073
<i>Juglans nigra</i>	4	.33	81.30	.062
<i>Celtis occidentalis</i>	4	.14	83.58	.049
<i>Ulmus rubra</i>	3	.05	97.50	.048
<i>Sporobolus neglectus</i>	3	.17	22.33	.048
<i>Gleditsia triacanthos</i>	2	.01	97.50	.046
<i>Dactylis glomerata</i>	*	.12	22.33	.043
<i>Lonicera japonica</i> *	.03		26.50	.042

Total species (1993): 90 (grass/sedges=25; woody=19; forbs=46); total exotic species: 21 (23%)

The next ten species, in order of importance value (1993): *Ulmus americana*, *Elephantopus carolinianus*, *Paspalum publiflorum*, *Sporobolus asper*, *Toxicodendron radicans*, *Tridens flavus*, *Acer negundo*, *Parthenocissus quinquefolia*, *Setaria glauca*, and *Panicum anceps*.

c. Unit 7C includes areas north of the northwest section of unit 7 that were not included (due to topography and proximity to floodplain) in the leasing or restoration areas of unit 7. Unit 7C is mostly open, with dense weedy cover and scattered woody growth. This area has never been monitored for species composition.

## 8. Unit 8

There is little information available on the land use history of this newly-designated area, located on a level section of land north and west of Harkins Branch. There is evidence that portions of it may have been in crops during the Gilmore occupation, but otherwise it was most likely used only for grazing. It is in very poor condition as a native ecosystem, containing large amounts of fescue and woody plant growth. No restoration actions have been undertaken in this unit, and no monitoring has been conducted. Restoration of this unit would involve the removal of a large amount of the woody plant growth and seeding native forb and grass species.

## C. Diamond Grove Prairie, a Restoration Model

The vegetative composition of local remnant prairies may provide good models on which to base species selection and seeding rates for prairie restoration. Diamond Grove Prairie, owned by the Missouri Department of Conservation, within 5 miles of the monument. Diamond Grove Prairie, a 515 acre upland prairie, is situated nine miles southeast of Joplin in Sec. 31 and 36, T27N, R38W in Newton County, Missouri. The vegetational composition of two sites near the east border of Diamond Grove were sampled in 1984 (Figure 2) (Solecki, et al. 1986). The two study sites occur on a gentle, southwest-facing slope and nearly level ridge underlain by Hoberg silt loam and Keeno cherty silt loam soils.

Both past and current management practices influence species composition. The eastern-most study site at Diamond Grove was a private hay meadow at the time of study, but was later acquired by the Missouri Department of Conservation. Diamond Grove Prairie was usually hayed each summer before the Missouri Department of Conservation acquired it in 1981, 1982, and 1985. The west study site was hayed in summer of 1983, as was the east site. Current management of Diamond Grove Prairie includes rotational summer haying and spring burning (Solecki et al. 1986).

Solecki et al. (1986) recorded 132 species in the 2 study sites at the Diamond Grove Prairie (Appendix VII). Thirty-three species with importance values of 25 or greater are listed in Table 1. Exotic species and those species that occur in a broad range of habitats were excluded from this list. Coefficients of community (Wilhelm and Ladd 1988) for Missouri flora (Ladd unpublished) were used to evaluate the affinity of a species for a particular community type. Those species with coefficients of community of 3 or lower were not included in Table 1. While ruderal species commonly occur on prairies, and may persist in high quality prairies by colonizing small-scale disturbances, they are not the defining feature of the prairie, and therefore are not the focus of our restoration work.

The table below shows a summary of data collected by Solecki et al (1986), combining the west and east sites to show the ten most important conservative species overall. Exotic species, omitted from the list below, composed only a small portion of the flora, with only six species. Only *Bromus racemosus*, with an importance

value of 22 on the East site, was present in any significant quantity. Monitoring results for this study (conducted in 1984) showed a total of 131 species. Of this total, 41 species (31%) were grasses and sedges, 26 (20%) were composites, 10 (8%) were legumes, 5 (4%) were woody species, and 49 (37%) were miscellaneous forbs.

Dominant species, Diamond Grove Prairie (1984)

Species	Coeff. of Cons.	Freq.	Cover	Importance Value
<i>Sporobolus heterolep.</i>	6	89	55	.144
<i>Andropogon scoparius</i>	5	96	48	.144
<i>Andropogon gerardii</i>	5	93	46	.139
<i>Sorghastrum nutans</i>	5	69	33	.102
<i>Panicum virgatum</i>	4	58	35	.093
<i>Panicum sphaerocarpon</i>	5	76	10	.086
<i>Psoralea psoralioides</i>	7	70	15	.085
<i>Carex meadii</i>	5	67	15	.082
<i>Rosa carolina</i>	4	70	11	.081
<i>Polygala sanguinea</i>	5	68	3	.071
<i>Lobelia spicata</i>	5	66	5	.071

Other important species include Fimbristylis caroliniana, Barbara's buttons (Marshallia caespitosa), sensitive briar (Schrankia uncinata), tickseed (Coreopsis grandiflora), lousewort (Pedicularis canadensis), ashly sunflower (Helianthus mollis), goat's rue (Tephrosia virginiana), June grass (Koeleria cristata) and pale purple coneflower (Echinacea pallida).

Total species: 131 (grass/sedges=31; woody=5; forbs=85)  
total exotic species: 6 (5%)

Monitoring done in 1993 (Wilson and Jackson, 1994) showed a considerably different species mix, with most of the species either already in abundance at George Washington Carver or with low importance values. Since the 1993 sampling was done in a perimeter site and was not as extensive as the 1984 sampling, the data will not be used as a model. However, two species from this survey are worth mentioning due to their high values at Diamond Grove and low values at Carver: *Andropogon ternarius* (CofC=5; Importance value=.096), and *Dichanthelium latifolium* (CofC=6;

Importance value=.075). These two species should be a part of the restoration model species mix.

For more detail on the Diamond Grove model, see Appendix VII.

**Table 1.** Species with coefficients of conservatism  $\geq 4$  and importance values  $\geq 25$ . **West Study Site.**

Latin Name	Common Name	Coefficient of Conservatism	Importance Value
Sporobolus heterolepis	prairie dropseed	6	144
Andropogon scoparius	little bluestem	5	138
Andropogon gerardii	big bluestem	5	108
Sorghastrum nutans	Indian grass	5	85
Psoralea psoralioides	Sampson's snakeroot	7	85
Carex meadii	sedge	5	82
Panicum virgatum	switch grass	4	77
Polygala sanguinea	milkwort	5	71
Marshallia caespitosa	Barbara's buttons	9	64
Schrankia uncinata	sensitive briar	6	59
Viola sagittata	arrow-leaved violet	7	59
Lobelia spicata	lobelia	5	58
Fimbristylis caroliniana		7	53
Coreopsis grandiflora	tickseed	6	51
Panicum sphaerocarpon	panic grass	5	48
Oenothera linifolia	sundrops	4	40
Pedicularis canadensis	lousewort	5	39
Scleria triglomerata	tall nut rush	7	38
Aristida sp.	three-awn grass		36
Physotegia angustifolia	false dragonhead	6	33
Tephrosia virginiana	goat's rue	5	33
Helianthus mollis	ashy sunflower	6	29
Panicum oligosanthos	panic grass	6	29
Scleria ciliata	nut rush	20	29
Stylosanthes biflora	pencil flower	5	29
Ceanothus americanus	New Jersey tea	7	28
Aster sp. (?)	aster		27
Echinacea pallida	pale purple coneflower	7	27
Koeleria cristata	June grass	6	25

**Table 2.** Vegetational composition of Diamond Grove Prairie. Species with coefficients of conservatism  $\geq 4$  and importance values  $\geq 25$ . **East Study Site.**

Latin Name	Common Name	Coefficient of Conservatism	Importance Value
Andropogon scoparius	little bluestem	5	144
Andropogon gerardii	big bluestem	5	139
Sorghastrum nutans	Indian grass	5	102
Panicum virgatum	switch grass	4	93
Sporobolus heterolepis	prairie dropseed	6	91
Panicum sphaerocarpon	panic grass	5	86
Rosa carolina	pasture rose	4	81
Lobelia spicata	pale spike lobelia	5	71
Marshallia caespitosa		9	68
Fimbristylis caroliniana		7	67
Psoralea psoralioides	Sampson's snakeroot	7	67
Coreopsis grandiflora	tickseed	6	59
Schrankia uncinata	sensitive briar	6	57
Viola sagittata	arrowhead violet	7	53
Carex meadii	sedge	5	52
Eleocharis sp.	spikerush		39
Helianthus mollis	ashy sunflower	6	38
Pedicularis canadensis	lousewort	5	38
Koeleria cristata	June grass	6	37
Liatris pycnostachya	blazing star	6	33
Polygala sanguinea	milkwort	5	33
Physotegia angustifolia	false dragonhead	6	31
Tephrosia virginiana	goat's rue	5	30
Penstemon sp.	beardtongue		28
Scleria triglomerata	nut-rush	7	26
Carex abdita	sedge	9	26



## IV. RESTORATION ACTION PLAN

## A. Forest restoration

The assessment of the forest/prairie ratio of the 1860-1870 historic period, as discussed earlier, is outside the scope of the Prairie Restoration Action Plan. A Vegetation Management Plan, to be completed after the Cultural Landscape Report and historic scene studies, will address any recommendations for the area currently covered by forest. At that time, the Action Plan will be revised to reflect management strategies.

## B. Prairie Restoration

## 1. Statement of standards

Restoration of the native prairie is essential to restore the natural scene of the 1860-1870 period of George Washington Carver's boyhood, and to attain the highest possible quality natural ecosystem native to this region of Missouri. The following standards will guide the restoration actions:

## a. Chronology of restoration actions

Actions will be undertaken annually under the direction of individual site plans (see Appendix I). The completion of the Cultural Landscape Report may result in changes needed in the overall focus and in the chronology of actions. Unless the CLR recommends otherwise, an evaluation of the Action Plan will be undertaken at the end of 1999 to determine whether a major revision of this plan is necessary at that time.

## b. Geographical scope

The restoration of prairie will continue in all areas currently under restoration with the addition of Unit 8 to the restoration program (see Figure 3). No areas of timber will be removed to reduce the proportion of woodland until a Cultural Landscape Report, Historic Scene Study, and Vegetation Management Plan are completed.

c. Restoration goals

Restoration of the prairie units will be conducted in a progression, beginning with Unit 3 and the Demonstration Prairie (see Appendix IV). Seeding success, determined by monitoring, will dictate when restoration will progress to units 1, 6, and 4 (in that order). Units 5 and 7, with a large amount of perennial warm season grass cover but no forb plantings, will be the last units to undergo restoration, and will be maintained in their current state, with efforts made to reduce amounts of switchgrass, pending the outcome of the Cultural Landscape Plan.

Species composition, diversity, and cover will be modeled after the Diamond Grove Prairie. Using the Coefficients of Conservatism values as developed by the Nature Conservancy (see Appendix V), the prairies of George Washington Carver will be restored to exhibit a similar species composition to that of Diamond Grove Prairie (see the Diamond Grove model, Appendix VII). Minimal management will be applied to hydric areas, which will be monitored for species composition, evaluated, and then managed under the direction of a sub-management plan to be ammended to the Action Plan.

Specific composition goals are as follows:

- Only species of grasses, forbs, woody plants, sedges, and others with a Coefficient value of 4 or more will be introduced into the prairie units in the park.

- Species shown from quantitative surveys to exhibit high importance values will be chosen for collecting at Diamond Grove. However, it may not be feasible to collect (and successfully propagate) all such species. Other species that, based on visual observations of Diamond Grove, exhibit high frequencies and coefficients of conservatism, will also be collected.

- Species with a Coefficient value of less than 4 will be actively reduced (especially in the case of noxious exotics) or allowed to be reduced through natural replacement by species with higher values. Species with values of less than 4 will be eliminated from the top ten species, in terms of cover and diversity, in each unit.

- Species with a Coefficient value of 4 and above will be favored, both passively (allowed to increase) and actively (introduced).

- Woody species will make up no more than 5% (collectively) of the species composition of each unit, and no woody species with a Coefficient value of less than 4 will exhibit an importance value (combined coverage and frequency) of more than 25. A few small clusters of woody vegetation will be allowed to persist to increase ecosystem diversity.

- Aggressive, adventive species (such as fescue and johnsongrass) will be controlled to levels that put them below the top ten species in terms of cover and frequency. Adventives will be controlled to importance values (combined coverage and frequency) of less than 25.

The Prairie Restoration Action Plan describes management actions during the restoration phase of prairie management. When the prairies reach the parameters of native species composition and cover, the development and implementation of a Prairie Management Plan will be developed to dictate further actions. All units will be managed individually until the above-stated goals are attained and the distinction between them is no longer necessary.

#### d. Seed procurement and care

The primary goal of seed collection, both at Diamond Grove and at the park, is to concentrate the initial planting in one small area. If successful, the planting will then provide a "seed bank" at the park for future seed collection. Unit 2 is the logical location for this seed bank (see Appendix I - Site Plan).

Determination of grass and forb species to be planted will be based on a combination of high Coefficients of Conservatism (CofC) values, high Importance Values, and ease of introduction (i.e.

emphasis will be on species that reproduce well from seed). Species with a CofC value of "4" or higher, and an Importance Value of "25", will be collected and planted. Only species native to this area of southwest Missouri, and present at Diamond Grove Prairie, will be planted. Seed will be collected from Diamond Grove prairie or from the park itself (once the species in the park are established from Diamond Grove seed). Seed collected at Diamond Grove prairie will be regulated by a permit from the Missouri Department of Conservation.

If seed is not available for collection from Diamond Grove, commercial dealers should be contacted (see Appendix VI). Seed should not be purchased without accompanying documentation of viability and purity at the time of purchase. Seed should originate within the prairie region of southwest Missouri (south of the Missouri River and west of the Ozark Plateau) and nearby southeastern Kansas (border counties south of Kansas City). Unused seed should be tested the following year for viability before planting (see Appendix VI -Supply Sources for seed testing sources). Seed should be stored in a cool, dry environment.

Due to the varying origins of species already planted in the park, NO SEED WILL BE COLLECTED AT THE PARK FOR THE FOLLOWING SPECIES\*:

Grasses:

Andropogon scoparius  
Andropogon gerardii  
Panicum virgatum  
Sorghastrum nutans  
Bouteloua curtipendula

Forbs:

Salvia azurea  
Lespedeza capitata  
Silphium laciniatum  
Helianthus maximiliani  
Liatris pycnostachya  
Liatris aspera  
Echinacea purpurea

\*until successful establishment from seed originating from Diamond Grove has been confirmed

e. Monitoring

During the summer and fall of 1993, the vegetation of all prairie units of the park, and in a portion of Diamond Grove prairie, were monitored (Wilson and Jackson, 1993). Quantitative sampling, measuring frequency and estimating cover, were used to compute species diversity and to obtain importance values for each species

in each unit. Monitoring will be conducted every three years, following the same methodology, to determine the progress towards matching the parameters found at Diamond Grove. Monitoring procedures are enclosed in Appendix III.

f. Definition of actions

The following are definitions of restoration actions for the purposes of this plan:

Seeding - Planting of native grass and/or forb seed. Grass and forb seed will be planted with a Truax drill, attached to a 40-hp or more tractor. Hand-seeding, or broadcasting, will be noted separately. Hand-seeding will be utilized in the establishment of the seed bank in unit 2 and in areas of less than 2 acres. The decision to use a particular species will be determined by a combination of seed size, method of introduction (such as seed versus transplants), overall suitability of the site (e.g. hydric versus mesic), special care and/or preparation involved, etc. In short, the overall feasibility of introducing the species must be considered. Seeding times will be determined by individual site plans.

Native grass - a mix of species as recommended by the Diamond Grove model (see Appendix VII). Seeding rates will be determined on a by-unit basis and stated in each respective site plan. Grass seeding will be conducted with either a Truax drill or by hand-seeding, depending on the size of area being seeded. Previous grass mixes used at the park included switchgrass (*Panicum virgatum*), and sideoats grama (*Bouteloua curtipendula*). Due to the aggressive nature and abundance of the former at the park, and due to the low frequency of the latter at Diamond Grove (see Solecki et al, 1986), the seeding of these species is no longer necessary.

Forbs - Solecki et al (1986) provided a list of forbs from which to determine important prairie species (see Appendix VII for a list of recommended species). Seeding rates will be determined on a by-unit basis and stated in each respective site plan.

Haying - Cutting, baling, and removal of vegetative material by and under agreement with the 4-H. Haying will be conducted annually in grass plantings (those areas not yet planted with forb

seed, i.e. units 5 and 7), and elsewhere on a cycle of once every several years. Units to be hayed will be pre-determined by the park, and the haying will be conducted during the first two weeks of July.

Mowing - This is the cutting down of overstory of forbs and grass, and the controlling woody plants and over-abundance of native perennials such as switchgrass. Unless otherwise noted, cutting height will result in 12 inches of stubble. Mowing will be conducted as conditions warrant (e.g. a large amount of undesirable forb or grass growth), and may be repeated in a particular unit during one growing season.

Prescribed burning - Planned burn of one or more units or portions of units under parameters set forth by a burn plan and site plan. The timing and interval of burns will depend on the purpose and the site needs. Early spring burns (February and March) will be conducted as needed to clear dead vegetation, to allow new growth of fescue for chemical treatment, to clear dead vegetation to facilitate grass planting, and increase spring soil temperatures. Late spring burns (late March through April) will be conducted every three years where needed to help control bluegrass and woody species. Early fall burns can be conducted, in units with well-established diversity to favor forbs the following year. Late fall/early winter burns (late November through January) will be conducted as needed to clear areas for forb planting.

Resting - Undertaking no restoration actions. No site plan will be developed for resting units, but may be included in site plans for other actions to units.

Disking - Light disking the top 2-3 inches of topsoil to prepare a seed-bed for planting grasses or forbs. This will only be used in areas that have not begun restoration, such as units 7C and 8, or in areas where control of fescue or switchgrass is needed. Heavy disking or plowing will not be conducted.

Exotic plant control - Removal and/or treatment of annual or perennial plants by mechanical and/or chemical means. The use of chemical herbicides is conducted only under approved pesticide use proposals for the approved use(s) by trained and authorized personnel. Control recommendations for the most serious problem species are included in Appendix VIII.

## 2. Restoration recommendations (by unit)

Restoration actions will be guided by site plans. Below is a general description of restoration needs for each unit. Units are in order of restoration priority.

Unit 2 - utilize the area for a seed bank (planting highly concentrated amounts of forb and grass seed for collecting). This unit is small, level, and well-drained. It is also easily accessible to vehicles. Some control of fescue may be necessary around perimeter areas.

Unit 3 - a small area with a moderately high species diversity, this will be the first unit to undergo seed planting. The east (level) portion: increase diversity of native grasses and introduce forbs. Treat area as somewhat hydric in species mix. West (sloping) portion: utilize fire, chemical, and mechanical means to control woody species. Increase diversity of grasses and forbs. Control encroachment of fescue around perimeter areas and actively reduce switchgrass (*Panicum virgatum*).

7B - remove fescue and other exotic cover and introduce forbs and native grasses. Remove all non-native trees, but ensure that walnut fence row remains intact. Due to its small size and its high visibility to visitors, this unit is one of the initial restoration areas. It will be utilized as a Demonstration Prairie (see Appendix IV).

Unit 6 - after monitoring has shown restoration actions to be successful in Unit 3 and the Demonstration Prairie, increase diversity of native grasses, control exotic species, and introduce forbs. Allow hydric areas to rest. Do not utilize haying. Control encroachment of fescue around perimeter areas.

Unit 1 - increase diversity of native forbs and grasses, once monitoring has shown that plantings have been successful in Unit 3, the Demonstration Prairie, and Unit 6. Utilize burning, chemical, and mechanical methods to control woody species. Control crown vetch (*Coronilla varia*), reduce switchgrass, and continue to monitor and control invasions of musk thistle (*Carduus nutans*) and sumac (*Rhus*, sp.).

Unit 4 (including 4A) - increase diversity of native forbs. Continue to burn when needed for controlling woody species and/or removing litter. Control bluegrass (*Poa*, sp.) and switchgrass, and encroachment of fescue around perimeter areas.

Unit 5 - initially, allow to remain a grass planting (while controlling switchgrass), alternating haying and burning. Once all other units have shown seeding success, initiate restoration actions. In the southwestern quarter, control exotic species, monitor, and allow to rest.

Unit 7 - initially, allow to remain a grass planting (while controlling switchgrass), alternating haying and burning. Once all other units have shown seeding success, initiate restoration actions. Actions in west half: increase diversity of native grasses and introduce forbs; northeast quarter: continue to introduce native grasses and begin introducing forbs; utilize burning, chemical, and mechanical means to control woody species; southeast quarter: continue to introduce native grasses and begin to introduce forbs. Monitor and control invasions of musk thistle. In all of the unit, control encroachment of fescue around perimeter areas.

7C - remove fescue and other exotic cover, including non-native trees, and introduce forbs and native grasses.

7A - leave off of restoration actions until a CLR and Vegetation Management Plan are completed.

Unit 8 - leave off of restoration actions until a CLR and Vegetation Management Plan are completed.

A site plan format is enclosed in Appendix I. These will be added to the plan as separate pages to facilitate changes.

### 3. Post-planting treatments and maintenance

All units will be on separate schedules for various restoration actions. As discussed above, the restoration of each unit will be guided by site plans, until a Cultural Landscape Report recommends



alternate treatment, or until a new assessment of the Action Plan is conducted in 1999.

C. Assessing restoration success

1. Objectives

a. To determine plant species presence and abundance in each of the park's prairie units and to represent the species with the ten highest importance values on distribution maps.

b. To determine the importance of each species in each management unit as this relates to vegetational classification and develop vegetation type maps of the units.

c. To contribute to the overall baseline natural resource data at the park.

d. To design management objectives that can be used to help restore the prairie vegetation to the historic scene of 1860-1870.

2. Methods

Monitoring will be designed after methods conducted in all prairie units, and Diamond Grove, during 1993 (see Wilson and Jackson, 1994). Monitoring will consist of the development of a species list and a quantitative vegetational analysis of the management units. This will involve the following steps: locating the sample plots in each management unit; determining the size of the sample plots; collecting data in each plot; analyzing data and developing importance values for each species in each management unit; determining diversity and evenness values for each management unit; and, determining management unit similarity using cluster analysis. A full description of monitoring and analysis methods is enclosed in Appendix III.

Follow-up monitoring at GWCA will be conducted at three-year intervals: 1996 and 1999. This will help to determine trends toward the model composition. Additional monitoring every five

years at Diamond Grove may be necessary to determine trends at that site.

### 3. Soils

During monitoring intervals (1996 and 1999, respectively), a soil analysis following Jackson (1985) will be conducted to compare changes since the initial restoration actions and to provide a soil baseline for the units not included in the initial study (units 5, 6, 7, and 7b).

## V. Potential impact of restoration on cultural resources

### A. Cultural resources that may be impacted by restoration

As noted earlier, a comprehensive historic scene study and Cultural Landscape Report is needed to determine the location of historic roads, trails, home sites, and other features. Of the archaeological sites documented by Benn (Figure 4), only sites 23NE163, 4, and 5, and Find A are located within the prairie restoration area. None of the five historic structures are located within the restoration area.

### B. Protective measures to avoid negative impact

The current level of restoration in the park does not require extensive soil turnover. Light disking may be conducted in some areas to prepare the seed bed for grass and forb planting. Disking will be avoided around the archaeological sites mentioned above. A seed drill will be used in these areas, a practice that subjects the soil to minimal impact.

## BIBLIOGRAPHY

- Benn, David W. 1982. An Intensive Archaeological Survey of George Washington Carver National Monument, Newton County, Missouri: 1981. National Park Service, Project CAR 490.
- Federal Interagency Committee for Wetland Delineation. 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative technical publication.
- Guyette, R. and E.A. McGinnes. 1982. Fire History of an Ozark Glade in Missouri. Transactions of the Missouri Academy of Science, Vol. 16, pp. 85-93.
- Jackson, J. 1985. The Analysis of the Restoration of the George Washington Carver National Monument Prairies for Fall 1981 to Summer 1985. GWCA files.
- Jackson, J. and B. Bensing. 1982. A Historic and Vegetational Survey of the Five Prairie Management Units at George Washington Carver National Monument. GWCA files.
- Ladd, Douglas. 1991. Reexamination of the Role of Fire in Missouri Oak Woodlands. Proceedings of the Oak Woods Management Workshop, Eastern Illinois University, Charleston IL, pp. 67-80.
- Palmer, Ernest J. 1983. The Flora and Natural History of George Washington Carver National Monument. U.S.D.I./N.P.S. (published posthumously).
- Schroeder, Walter A. 1983. Presettlement Prairie of Missouri. Conservation Commission of Missouri.
- Smith, Tim. 1993. Missouri Vegetation Manual. Missouri Department of Conservation, Jefferson City.
- Solecki, Mary K. and John B. Taft, Elizabeth A. Cook, and Pamela S.

Haverland. 1986. Vegetational Composition of Three Missouri Tallgrass Prairies With Reference to Management. Conservation Commission of the State of Missouri.

Toogood, A. 1973. Historic Resource Study and Administrative History of George Washington Carver National Monument. GWCA files.

United States Department of Agriculture. 1982. Soil Conservation Service, Soil Survey of Newton County, Missouri. United States Printing Office.

United States Fish and Wildlife Service. 1988. National List of Plant Species that Occur in Wetlands: Missouri. U.S. Department of the Interior. Biological report.

Wilhelm, G. and D. Ladd. 1988. Natural Area Assessment in the Chicago Region. Transactions of the 53rd North America Wildlife and Natural Resources Conference.

Wilson, Louise and James R. Jackson. 1994. George Washington Carver National Monument, Prairie Management Baseline and Monitoring Program. Draft report for the National Park Service.

Other sources in George Washington Carver National Monument files:

Benson, Tammy G. 1993. Statement for Interpretation.

Davis, Gentry. 1984. Fire Management Plan.

Davis, Gentry. 1984. Prairie Restoration Action Plan.

Davis, Gentry. 1984. Resources Management Plan.

Neal, John. 1992. Statement for Management.

Rumberg, Joseph C. 1964. Master Plan for the Preservation and Use

of George Washington Carver National Monument.

APPENDIX I

SAMPLE OF PRAIRIE RESTORATION SITE PLAN

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**PRAIRIE RESTORATION SITE PLAN**

George Washington Carver National Monument

**LOCATION:** Unit 2**SIZE:** 2.8 acres**PROJECT PERIOD:** May, 1994 - December, 1995**SITE HISTORY**

Known on old maps also as Unit 2, this area was under tillage at various times earlier in the century, but is especially notable for heavy grazing both before and after the establishment of the park. Grazing was discontinued after 1981, and restoration continued thereafter. Thus far, restoration actions have included:

<u>YEAR</u>	<u>ACTION</u>
1982	plowing and seeding grass; mowing overstory
1983	grazing; seeding grass
1984	prescribed burn; seeding forbs
1985	mowing overstory
1986	rest
1987	mowing overstory
1988	mowing overstory
1989	prescribed burn; mowing overstory
1990	rest
1991	prescribed burn; haying
1992	hay
1993	rest; monitoring
1994	prescribed burn; hand-seeding forbs/grasses

The site currently exhibits a strong diversity and cover of native warm-season grass and a low occurrence of native forbs. Data collected in 1982 (Jackson and Bensing) showed the following ten species as dominant in terms of importance values: *Festuca arundinacea*, *Cerastium vulgatum*, *Paspalum ciliatifolium*, *Oxalis stricta*, *Eleusine indica*, *Paspalum laeve*, *Eragrostis* spp., *Taraxacum officinalis*, *Tridens flavus*, and *Carex* spp.

The enclosed table shows data extracted from sampling conducted during 1993, in order of importance value. The five most



important species were, respectively, *Panicum virgatum*, *Andropogon gerardi*, *Sorghastrum nutans*, *Festuca arundinacea*, and *Andropogon scoparius* (summer); and *Sorghastrum nutans*, *Andropogon gerardi*, *Andropogon scoparius*, *Panicum virgatum*, and *Festuca arundinacea* (fall).

Summer results showed that, of the 29 species of forbs found in the unit, five were adventives and only eight had a Coefficient of Conservatism of 4 or above. Fall results showed 20 forbs, 4 of which were adventives and 4 species with a Coefficient of 4 or more.

#### **SITE OBJECTIVE**

The main objective is to utilize this small, level, well-drained unit as a site for developing a seed bank of forb and grass species. Seeds collected at Diamond Grove Prairie (and elsewhere in the park) will be planted in quantities designed for maximum seed production (i.e. as opposed to planting to reflect natural frequency per acre on a native prairie site). The site does not have an adequate diversity or seed bank potential of native forbs (and a few grass species are also lacking). A combination of cultural, mechanical, and seed introduction methods is necessary to increase the diversity of native forbs and additional grass species to maximize cover of seed-bearing plants for future harvesting.

#### **SITE ANALYSIS**

**Existing vegetation.** The unit has a good mix and cover of some species of native grasses, but has a low diversity of native forbs. Considerable amounts of fescue exist along the western and southern edges, but otherwise exotic species are not seriously threatening the flora. Very little woody vegetation occurs in the unit.

**Soils.** The entire unit is underlain by Secesh-Cedargap silt loams, characteristic of areas along intermittent or perennial streams. The unit is essentially level, with no perceptible slopes.

**Topography and hydrology.** The area is essentially level, with no perceptible slopes. There are no low areas that exhibit seasonal patterns of standing water.

#### **ARCHAEOLOGICAL CONCERNS**

No known archaeological sites exist within this unit. Light scraping (breaking the soil surface) will be used periodically to help favor forb growth. Other restoration methods planned include haying, burning, and mechanical removal of woody species. These actions will provide a minimum of protection to any undiscovered sites. Mitigation practices may be undertaken pending a more extensive archaeological investigation of the unit.

#### **RESTORATION STRATEGIES**

During the period December 1-20, 1994, the unit will undergo a complete burn, then will be scraped (breaking the soil surface), and then seeded with native forbs and grasses. Seeding will be conducted in several ten-foot-wide rows across the unit. Monitoring during 1995 will determine the success of forb planting and determine further need for forbs.

**SEED ACQUISITION AND PLANTING MIX**

Seeds to be used in planting will be collected during the fall, 1994 (and subsequent years), at various sites in Diamond Grove Prairie, 5 miles northwest of the park. Species to be collected and planted are shown below. The list is compiled from 1984 monitoring (Solecki et al, 1986), and is made up of species with an importance value of at least 25 and a Coefficient of Conservatism of 4 or more. Species not shown on the list that have similar CofC values, and that are visually observed to occur regularly and frequently at Diamond Grove, will also be collected.

Seeds will be mixed with a filler of 50 pounds cotton seed hulls and hand-broadcast over the unit within 10 days following the prescribed burn.

SPECIES

prairie dropseed (*Sporobolus heterolepis*)  
June grass (*Koeleria cristata*)  
Sampson's snakeroot (*Psoralea psoralioides*)  
milkwort (*Polygala sanguinea*)  
Barbara's buttons (*Marshallia caespitosa*)  
sensitive briar (*Schrankia uncinata*)  
lobelia (*Lobelia spicata*)  
sedge (*Fimbristylis caroliniana*)  
tickseed (*Coreopsis grandiflora*)  
sundrops (*Oenothera linifolia*)  
lousewort (*Pedicularis canadensis*)  
false dragonhead (*Physostegia angustifolia*)  
goat's rue (*Tephrosia virginiana*)  
ashy sunflower (*Helianthus mollis*)  
pencil flower (*Stylosanthes biflora*)  
New Jersey tea (*Ceanothus americanus*)  
pale purple coneflower (*Echinacea pallida*)  
pasture rose (*Rosa carolina*)  
blazing star (*Liatris pycnostachya*)  
beardtongue (*Penstemon tubaeflorus*)

TOTAL SPECIES: 18

**MONITORING**

Coverage and frequency transects will be conducted in the summer and fall of 1996, using methods and transects employed during 1993 sampling. This may allow a determination of forb planting success.

APPENDIX II

PRAIRIE RESTORATION ACTION SUMMARY BY YEAR, GWCA  
1982-1994



## Action summary for 1982

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking		X					X	
Mowing (overstory of weeds)	X JUN/ AUG	X AUG						
Seeding - grass	X MAY	X MAY	X	X				
Seeding - forbs (includes planting of seedlings: #)								
Haying								
Prescribed burn	X MAR		X MAR	X MAY				
Rest								
Agricultural lease (grazing)		X			X			
Historic lease (cropping)						X	X	
Weed/woody control		C	C					

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H=herbicide; C= hand-cut; M=mow		tree	tree					
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer



## Action summary for 1983

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking								
Mowing (overstory of weeds)			X JUN	X JUN				
Seeding - grass	X MAY	X MAY		X MAY				
Seeding - forbs (includes planting of seedlings: #)				X JUL#				
Haying								
Prescribed burn	X MAR		X MAR	X MAY				
Rest								
Agricultural lease (grazing)		X			X			
Historic lease (cropping)						X	X	
Weed/woody control			C;	H (5)				

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H=herbicide; C= hand-cut; M=mow			H s. JUL	JUN/ AUG				
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer; s.=south

## Action summary for 1984

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking			X APR					
Mowing (overstory of weeds)	X JUN			X JUN (5)				
Seeding - grass								
Seeding - forbs (includes planting of seedlings: #)	X M-J MAY#	X JUN MAY#	X MAY# JUN	X(5) APR- JUN#				
Haying				X MAY (4)				
Prescribed burn		X APR	X APR	X MAR (4)				
Rest								
Agricultural lease (grazing)								
Historic lease (cropping)					X	X	X	
Weed/woody control			H	H(5)				

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H=herbicide; C= hand-cut; M=mow			MAY S.	C(5)				
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer; s.=south

## Action summary for 1985

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking							X MAY (9)	
Mowing (overstory of weeds)		X AUG	X JUN			X JUN	X (9)	
Seeding - grass				X MAY (4)		X MAY/ JUN	X MAY (9)	
Seeding - forbs (includes planting of seedlings: #)				X(5) sum- mer				
Haying								
Prescribed burn								
Rest	X							
Agricultural lease (grazing)								
Historic lease (cropping)					X			
Weed/woody control				H		H	H	

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H=herbicide; C= hand-cut; M=mow				JUN (4)			(9)	
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1986

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking								
Mowing (overstory of weeds)	X JUL west		X SEP	X (e4, 5)		X SEP		
Seeding - grass								
Seeding - forbs (includes planting of seedlings: #)				X MAY all				
Haying								
Prescribed burn								
Rest		X						
Agricultural lease (grazing)								
Historic lease (cropping)					X		X	
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer



## Action summary for 1987

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking						X APR	X APR (9)	
Mowing (overstory of weeds)	X JUL	X MAY/ JUL	X MAY/ JUL	X MAY/ JUL				
Seeding - grass						X APR e.	X MAY (e9)	
Seeding - forbs (includes planting of seedlings: #)						X APR/ JUN		
Haying								
Prescribed burn								
Rest								
Agricultural lease (grazing)								
Historic lease (cropping)					X	X fall	X (w9) fall	
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1988

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking								
Mowing (overstory of weeds)	X JUL- AUG	X JUN/ AUG	X JUN/ AUG	all MAY- AUG		X MAY	X AUG (9)	
Seeding - grass			X MAY			X MAY	X MAY (9)	
Seeding - forbs (includes planting of seedlings: #)			X MAY			X MAY	X MAY (9)	
Haying								
Prescribed burn				X APR			X APR (9)	
Rest								
Agricultural lease (grazing)								
Historic lease (cropping)					X		X	
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1989

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking							X MAR (n9)	
Mowing (overstory of weeds)	X JUL	X JUN		all JUN		X JUN/ OCT	X JUL	
Seeding - grass							X MAR (n9)	
Seeding - forbs (includes planting of seedlings: #)								
Haying								
Prescribed burn	X APR	X APR				X APR e.	X APR (9)	
Rest			X					
Agricultural lease (grazing)								
Historic lease (cropping)					X		X	
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1990

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking					X spr		X sum w.	
Mowing (overstory of weeds)					X sum		all but n.e.	
Seeding - grass					X spr		X e.	
Seeding - forbs (includes planting of seedlings: #)								
Haying								
Prescribed burn			X spr	X spr		X spr	X spr w.	
Rest	X	X						
Agricultural lease (grazing)		NO SUCH ACTIONS						
Historic lease (cropping)		NO SUCH ACTIONS						
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer



## Action summary for 1991

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking						X		
Mowing (overstory of weeds)					X MAY/ JUN		X MAY/ JUN	
Seeding - grass						X		
Seeding - forbs (includes planting of seedlings: #)								
Haying	X JUL	X JUL		X JUL				
Prescribed burn	X spr	X spr	X spr	X spr			X spr e.	
Rest								
Agricultural lease (grazing)		NO SUCH ACTIONS						
Historic lease (cropping)		NO SUCH ACTIONS						
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1992

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking								
Mowing (overstory of weeds)					X JUN- JUL	X JUN	JUN w./ n.e.	
Seeding - grass					all but s.w.		APR w./ n.e.	
Seeding - forbs (includes planting of seedlings: #)								
Haying	X JUL	X JUL	X JUL east					
Prescribed burn					X APR n.	X MAR	X MAR w.	
Rest				X				
Agricultural lease (grazing)		NO SUCH ACTIONS						
Historic lease (cropping)		NO SUCH ACTIONS						
Weed/woody control								

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H=herbicide; C= hand-cut; M=mow								
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\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1993

Action	Unit*							
	1	2	3	4	5	6	7	8
Plowing/disking		NO SUCH ACTIONS						
Mowing (overstory of weeds)					X JUN		X JUN	
Seeding - grass					APR s.e. s.w.		APR s.e.	
Seeding - forbs (includes planting of seedlings: #)								
Haying		NO SUCH ACTIONS						
Prescribed burn								
Rest	X		X			X		X
Agricultural lease (grazing)		NO SUCH ACTIONS						
Historic lease (cropping)		NO SUCH ACTIONS						
Weed/woody control				C	H	C	C	

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H=herbicide; C= hand-cut; M=mow								
------------------------------------	--	--	--	--	--	--	--	--

\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer

## Action summary for 1994

Action	Unit*							
	1	2	3	4	5	6	7	7b
Plowing/disking		NO SUCH ACTIONS						
Mowing (overstory of weeds)		NO SUCH ACTIONS						
Seeding - grass		X DEC						
Seeding - forbs (includes planting of seedlings: #)		X DEC						
Haying		NO SUCH ACTIONS						
Prescribed burn	X APR	X DEC	X APR	X APR			X APR east	
Rest					X	X		X
Agricultural lease (grazing)		NO SUCH ACTIONS						
Historic lease (cropping)		NO SUCH ACTIONS						
Weed/woody control	H			C	C		C	

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H=herbicide; C= hand-cut; M=mow								
------------------------------------	--	--	--	--	--	--	--	--

\*old unit numbers are shown in parentheses

Abbreviations: n.=north; s.e.=southeast; n.e.=northeast; w.=west;  
e.=east; spr=spring; sum=summer



## PRAIRIE RESTORATION ACTIONS, GENERAL SUMMARY

1982-1994

YEAR	UNIT						
	1	2	3	4	5	6	7
1982	B, M, Sg	D, Sg, W, M	B, Sg, W	B, Sg	Lg	Lc	Lc
1983	B, Sg	Sg	B, M, W	B, Sg, M, W, Sf	Lg	Lc	Lc
1984	M, Sf	B, Sf	B, D, Sf, W	B, H, W, Sf	Lc	Lc	Lc
1985	R	M	M	W, Sf	Lc	Sg, M, W	D, Sg, M, W
1986	M	R	M	M, Sf	Lc	M	R
1987	M	M	M	M	Lc	D, Sg, Sf Lc	D, Sg, Lc
1988	M	M	M, Sg, Sf	B, M	Lc	M, Sg, Sf	B, Sg, Sf M
1989	B, M	B, M	R	M	Lc	B, M	B, D, Sg, M
1990	R	R	B	B	D, Sg, M	B	B, D, Sg, M
1991	B, H	B, H	B	B, H	M	D, Sg	B, M
1992	H	H	H, M	R	B, Sg, M	M	B, Sg, M
1993	R	B, Sf	R	B, W	Sg, M W	R, W	Sg, M W

**PRAIRIE RESTORATION ACTION PLAN**

**GWCA, 1995**

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1994	B, W	B, Sf, Sg	B	B, W	R, W	R	B, W
------	------	--------------	---	------	------	---	------

B = prescribed burn

H = haying; R = rest

Lg = agricultural lease (grazing)

W = weed/woody control

D= disking/plowing

Lc = historic lease (cropping)

M = mowing overstory

Sf = seeding forbs; Sg = grass

APPENDIX III

**MONITORING AND ANALYSIS METHODS**

Exerpted from Wilson and Jackson, 1994

APPENDIX IV

DEMONSTRATION PRAIRIE PLAN

## DEMONSTRATION PRAIRIE PLAN

## UNIT 7B

## George Washington Carver National Monument

## I. Introduction

Native tallgrass prairie, once prevalent in Missouri, exists in only a few isolated areas in the western part of the state. At George Washington Carver National Monument, efforts have been undertaken to restore all non-forest areas to prairie, using areas determined to be in prairie during the historic period of 1860-1870.

Prairie is rather poorly understood by the general public, often being perceived as "grassland". There are only a handful of areas in the United States where the public can observe and learn about prairie. The best opportunities for prairie interpretation in our region are at Prairie State Park (north of Joplin, Missouri) and the Tallgrass Prairie Preserve (near Pawhuska, Oklahoma). At Prairie State Park, visitor center displays and nature trails help the visitor to understand prairie ecology and many of the common plants. The Nature Conservancy's Tallgrass Prairie Preserve contains more than 30,000 acres of prairie. Prairie-savannah, an even less-understood ecosystem, exists virtually nowhere in Missouri in its original condition.

A special prairie area, created and maintained for interpretive and ecological purposes, is needed at George Washington Carver. Justification for its development is summarized here:

1. To assist in educating the visitor about prairies.
2. To allow the visitor the opportunity to observe prairie and many of its common species through on-site interpretive media.
3. To restore another area of the park that is not yet part of the prairie restoration process.
4. The interpretation of prairie and its importance to agriculture.

## II. Location of site

The demonstration prairie would best be located in unit 7b, north of and adjacent to the picnic area. Currently, the site consists of a 2.25 acre stand of grass (predominantly fescue) and weeds (especially horseweed, ragweed, and poison ivy) with scattered large trees. A walnut fence row of unknown origin is present within the site and must be preserved. The site is ideal for the development of a demonstration prairie with emphasis on the prairie-savannah and/or prairie as an agricultural resource.

### III. Prairie restoration actions

Despite the presence of trees, the area will undergo a management process similar to that of the park's other prairie units, except that restoration will be conducted in small portions of the unit over several years. Of particular concern is the presence of large quantities of fescue and woody plants in the unit. Management actions will be incorporated into the prairie action schedule for the park. A chronology of the restoration actions is shown below:

March, 1995 - Prescribed burn to remove dead vegetation and turn over nutrients. Upon regrowth of fescue, chemical spot-treatment will be conducted for control. Removal of non-native trees (e.g. mulberry).

April, 1995 - Spot-seeding of the unit (in selected, small areas) with native grass and forb mix (see enclosed list for species and seeding rates).

May/June/July, 1995 - Mowing, as needed, to eliminate overstory of forbs.

August, 1995 - Application of herbicide (cut stem) to woody plants such as poison ivy, sumac, and tree seedlings.

November, 1995 - Application of foliar herbicide to fescue in the unit before first prolonged cold spell.

April, 1996 - Continue spot-seeding of the unit with native grass and forb mix.

May/June/July, 1996 - Mowing, as needed, to eliminate overstory of forbs.

August, 1996 - Application of herbicide (cut stem) to control woody species.

November, 1996 - Application of foliar herbicide to fescue.

April, 1997 - Continue spot-seeding of the unit with native grass and forb mix.

May/June, 1997 - Mowing, as needed, to eliminate overstory of undesirable forbs.

August, 1997 - Application of herbicide (cut stem) to control woody species.

December, 1997 - Prescribed burn to remove vegetative cover and prepare for seeding. Seeding of native wildflower mix (see enclosed list for species and seeding rates).

#### IV. Interpretation

1. An interpretive display to be constructed in the visitor center to describe both general prairie characteristics and demonstration prairie practices, details, and progress.

2. An illustrated site bulletin to be created to address both the prairie management program and the restoration of the demonstration prairie. The bulletin will describe prairie characteristics, common plant and animal species, and the restoration process (step-by-step). It will also address the demonstration prairie--its purposes, the restoration process, and the qualities of a prairie-savannah. The bulletin would be available at the visitor center, for mail-out inquiries, and at the demonstration prairie site.

3. An interpretive panel to be placed on the demonstration prairie site. It will include basic prairie restoration information relating to the site and instruct visitors to respect the restoration efforts by not trampling the area.

At the completion of the restoration phase of the demonstration prairie, two more interpretive panels will be placed on the site,

one depicting several species of common prairie grasses and wildflowers, and the second describing the prairie ecosystem.

4. A bulletin board, with changing displays of various prairie-oriented topics, to be installed either at the visitor center or near the demonstration prairie site.

#### V. Special considerations

1. A few new safety concerns will need to be addressed. Trees within this site will be added to the Hazard Tree Program, and any determined to be hazardous will be removed. Safety considerations should warrant that the demonstration prairie be off limits to visitor use. Poison ivy and ticks, in addition to the delicate nature of the restoration process, would require restricting access.

2. Since the area will be adjacent to the picnic area, a heavily used portion of the park, adequate awareness must be provided to visitors about the importance of the program and their cooperation with it. Brochures, signage, and oral communication would be helpful.

3. In addition to information about prairies, the public should also be educated about the importance of using native plants for planting around homes and businesses. Prairie plant seed packets, formerly sold at the visitor center through CBA, should be again made available.



## NATIVE PERENNIAL GRASS SPECIES

SPECIES (total=5)

big bluestem (*Andropogon gerardii*)  
little bluestem (*Schizachirium scoparium*)  
prairie dropseed (*Sporobolous heterolepis*)  
June grass (*Koeleria cristata*)  
indiangrass (*Sorghastrum nutans*)  
bluestem (*Andropogon ternarius*)  
panicum (*Dichanthelium latifolium*)

## FORB SPECIES

SPECIES (total=18)

Sampson's snakeroot (*Psoralea psoralioides*)  
milkwort (*Polygala sanguinea*)  
Barbara's buttons (*Marshallia caespitosa*)  
sensitive briar (*Schrankia uncinata*)  
lobelia (*Lobelia spicata*)  
sedge (*Fimbristylis caroliniana*)  
tickseed (*Coreopsis grandiflora*)  
sundrops (*Oenothera linifolia*)  
lousewort (*Pedicularis canadensis*)  
false dragonhead (*Physostegia angustifolia*)  
goat's rue (*Tephrosia virginiana*)  
ashy sunflower (*Helianthus mollis*)  
pencil flower (*Stylosanthes biflora*)  
New Jersey tea (*Ceanothus americanus*)  
pale purple coneflower (*Echinacea pallida*)  
pasture rose (*Rosa carolina*)  
blazing star (*Liatris pycnostachya*)  
beardtongue (*Penstemon tubaeflorus*)

APPENDIX V

**COEFFICIENTS OF CONSERVATISM**

The following is a table of Missouri flora with Coefficient  
values assigned

APPENDIX VI  
SUPPLY SOURCES

SUPPLY SOURCES

PRAIRIE RESTORATION

Truax seed drill:

Lynn Jenkins, Soil Conservation Service, Neosho, 451-1366

Haying (under Memorandum of Understanding): 4-H of Newton County,  
c/o Roy Carter, U. of Mo. Extension Service, Neosho, 451-8202

Cotton Seed Hulls:

Phil Ratliff Feed, 201 N. Washington, Neosho, MO 64850  
451-4335

Danel's Feed and Farm Supplies, 1326 Joplin, Joplin, MO  
64801  
623-7772

Seeding information and advice:

Mervin Wallace  
Missouri Wildflowers Nursery  
9814 Pleasant Hill Road  
Jefferson City, MO 65109  
(314)-496-3492

Tom Toney, Mo. Dept. of Conservation  
(417)-232-4619

Steve Clubine, Mo. Dept. of Conservation  
P.O. Box 250  
Clinton, MO 64735  
(816)-885-6981

Forb and grass seed:

Bluestem Seed Company  
9416 High Dr.  
Leawood, KS 66206  
(816)-786-2401

Johnson Seed Company

Box 1392, 411 W. Chestnut  
Enid, OK 73702  
(405)-233-5800

Sharp Brothers Seed Company  
Route 4, Box 237A  
Clinton, MO 64735  
(816)-885-7551

Appendix VI, cont.

Forb and grass seed, cont.

Missouri Wildflowers Nursery  
9814 Pleasant Hill Road  
Jefferson City, MO 65109  
(314)-496-3492

Hamilton Seed and Wildflowers  
HC Route 9, Box 138  
Elk Creek, MO 65464  
(417)-967-2190

Seed testing:

Hulsey Seed Laboratory                      full range of testing  
P.O. Box 132  
Decatur, GA 30031-0132  
(404)-294-5450

Missouri Southern State College              may perform limited  
Dr. James Jackson                      testing  
(417)-625-9578

Other agencies/organizations:

Missouri Department of Conservation (re: Diamond  
Grove Prairie), Mark Hutchins, Pierce City; phone:  
or (417)-895-6880

Missouri Prairie Foundation

P.O. Box 6906  
Columbia, MO 65205

The Nature Conservancy  
2800 S. Brentwood Blvd.  
St. Louis, MO 63144  
(314)-968-1105

Prairie State Park (Missouri Department of Natural Resources)  
1-843-6711

Dr. James Jackson  
Department of Biology  
Missouri Southern State College  
Joplin, MO 64801  
1-625-9578

APPENDIX VII  
DIAMOND GROVE PRAIRIE  
SPECIES COMPOSITION SUMMARY  
AND  
MODEL FOR RESTORATION

## DIAMOND GROVE PRAIRIE

## 1. General information

Solecki et al (1986) describes the Diamond Grove prairie as a 515-acre "upland prairie". It is located nine miles southeast of Joplin in Sec. 31 and 36, T27N, R32W in Newton County, Missouri, and about five miles northwest of George Washington Carver National Monument. Soils at Diamond Grove, especially Hoberg silt loam and Keeno cherty silt loams, are very similar to the upland soils at George Washington Carver. Lowland soils such as Carytown and Wanda, present in several areas of the monument, are absent from Diamond Grove. The only known use for Diamond Grove prairie, prior to its acquisition by the state, was annual summer haying.

Sampling was conducted at Diamond Grove during 1984 by the Missouri Department of Conservation, providing a good summary of the most important species as far as cover and diversity. Species summaries, along with a set of tables showing the most important species as far as high coefficient and importance values, are enclosed on the next few pages. The following list summarizes these tables, showing simply a list of species from which to choose for restoration purposes:

## Grasses:

- big bluestem (*Andropogon gerardii*)
- little blue stem (*Schizachrium scoparium*)
- indiangrass (*Sorghastrum nutans*)
- prairie dropseed (*Sporobolus heterolepis*)
- June grass (*Koeleria cristata*)
- panic grass (*Dichanthelium latifolium*)
- bluestem (*Andropogon ternarius*)

## Forbs:

- Sampson's snakeroot (*Psoralea psoralioides*)
- milkwort (*Polygala sanguinea*)
- Barbara's buttons (*Marshallia caespitosa*)
- sensitive briar (*Schrankia uncinata*)
- lobelia (*Lobelia spicata*)
- sedge (*Fimbristylis caroliniana*)
- tickseed (*Coreopsis grandiflora*)
- sundrops (*Oenothera linifolia*)
- lousewort (*Pedicularis canadensis*)
- false dragonhead (*Physostegia angustifolia*)



goat's rue (*Tephrosia virginiana*)  
ashy sunflower (*Helianthus mollis*)  
pencil flower (*Stylosanthes biflora*)  
New Jersey tea (*Ceanothus americanus*)  
pale purple coneflower (*Echinacea pallida*)  
pasture rose (*Rosa carolina*)  
blazing star (*Liatris pycnostachya*)  
beardtongue (*Penstemon tubaeflorus*)

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2. Monitoring results, 1984 - Solecki et al (1986)**Sampling Methods And Species Summary for Diamond Grove Prairie.**

Excerpt from Solecki, M.K., J.B. Taft, E.A. Cook and P.S. Haverland. 1986. Vegetational Composition of Three Missouri Tallgrass Prairies with Reference to Past Management. Conservation Commission of the State of Missouri, 93 pp.

**Methods**

Vegetation at each site was sampled in the summer of 1984 (June 18-29) with ninety 0.5 m<sup>2</sup> rectangular plots (50 X 100 cm) placed on midslopes, to upper slopes, or ridgetops at each site. Lower slopes and ravines were not sampled. Disturbed sites, such as mima mounds containing animal holes, were avoided. Plot location was chosen by : 1)looking at the second hand of a wrist watch, 2)walking in the direction the second hand indicated, considering 12:00 as north, and 3)walking the number of paces the second hand indicated, with the number of paces ranging from 1 to 60. The location of the previous plot was the starting point for choosing a new plot. After 45 plots were completed in this manner at a site, the remaining 45 plots were located by considering 12:00 on the wrist watch as south, rather than north. this partially compensated for the sampling bias of walking further distances in a westerly direction (between 30 and 60 paces) and shorter distances in an easterly direction (between 1 and 29 paces) when 12:00 was considered as north.

The canopy cover of each vascular plant species within a plot was recorded using the Daubenmire cover scale (Daubenmire 1959, 1968) with modifications following Bailey and Poulton (1968). Canopy cover is the area, parallel to the ground surface, bounded by a line connecting the extremities of the living parts of a plant's crown (figure 4) and is expressed as a percent of the plot size (Daubenmire 1959). canopy coverage was determined for each species occurring within a plot, regardless of where the plant was rooted and regardless of the overlapping of canopies of different species. since the canopies of different species were often interconnected or superimposed, the canopy cover percents often total over 100%. The modified Daubenmire cover scale is as follows: class 1, 0-1%; class 2, 1-5%; class 3, 5-25%; class 4, 25-50% class 5, 50-75%; class 6, 75-95%; and class 7, 95-100%. Cardboard squares representing 1% and 5% of the plot area were used as guides in cover estimation.

Voucher specimens of all plant species collected are deposited with the Missouri Department of Conservation, Jefferson city, Missouri. Taxonomic nomenclature follows Steyermark (1963). Carex abdita and Carex umbellata have similar morphology, with

only a slight difference in perigynium structure. Since all specimens of this complex that were collected were identified as *C. abdita*, it was assumed that all plants of this group encountered during sapling were *C. abdita*. Some nonreproductive specimens could only be identified to genus, family, or class.

Vegetational data were summarized by calculating the relative frequency and average canopy cover of each plant species sampled at each unit per season. Cover class midpoints were used to calculate average canopy cover. Relative frequency and average canopy cover values for each species sampled in each unit and season were added to calculate an importance value with a maximum value of 200.

**Table 1.** Species with coefficients of conservatism  $\geq 4$  and importance values  $\geq 25$ . **West Study Site.**

Latin Name	Common Name	Coefficient of Conservatism	Importance Value
<i>Sporobolus heterolepis</i>	prairie dropseed	6	144
<i>Andropogon scoparius</i>	little bluestem	5	138
<i>Andropogon gerardii</i>	big bluestem	5	108
<i>Sorghastrum nutans</i>	Indian grass	5	85
<i>Psoralea psoraloides</i>	Sampson's snakeroot	7	85
<i>Carex meadii</i>	sedge	5	82
<i>Panicum virgatum</i>	switch grass	4	77
<i>Polygala sanguinea</i>	milkwort	5	71
<i>Marshallia caespitosa</i>	Barbara's buttons	9	64
<i>Schrankia uncinata</i>	sensitive briar	6	59
<i>Viola sagittata</i>	arrow-leaved violet	7	59
<i>Lobelia spicata</i>	lobelia	5	58
<i>Fimbristylis caroliniana</i>		7	53
<i>Coreopsis grandiflora</i>	tickseed	6	51
<i>Panicum sphaerocarpon</i>	panic grass	5	48
<i>Oenothera linifolia</i>	sundrops	4	40
<i>Pedicularis canadensis</i>	lousewort	5	39
<i>Scleria triglomerata</i>	tall nut rush	7	38
<i>Aristida</i> sp.	three-awn grass		36
<i>Physotegia angustifolia</i>	false dragonhead	6	33
<i>Tephrosia virginiana</i>	goat's rue	5	33
<i>Helianthus mollis</i>	ashy sunflower	6	29
<i>Panicum oligosanthos</i>	panic grass	6	29
<i>Scleria ciliata</i>	nut rush	20	29

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Stylosanthes biflora	pencil flower	5	29
Ceanothus americanus	New Jersey tea	7	28
Aster sp. (?)	aster		27
Echinacea pallida	pale purple coneflower	7	27
Koeleria cristata	June grass	6	25

**Table 2.** Vegetational composition of Diamond Grove Prairie. Species with coefficients of conservatism  $\geq 4$  and importance values  $\geq 25$ . **East Study Site.**

Latin Name	Common Name	Coefficient of Conservatism	Importance Value
Andropogon scoparius	little bluestem	5	144
Andropogon gerardii	big bluestem	5	139
Sorghastrum nutans	Indian grass	5	102
Panicum virgatum	switch grass	4	93
Sporobolus heterolepis	prairie dropseed	6	91
Panicum sphaerocarpon	panic grass	5	86
Rosa carolina	pasture rose	4	81
Lobelia spicata	pale spike lobelia	5	71
Marshallia caespitosa		9	68
Fimbristylis caroliniana		7	67
Psoralea psoralioides	Sampson's snakeroot	7	67
Coreopsis grandiflora	tickseed	6	59
Schrankia uncinata	sensitive briar	6	57
Viola sagittata	arrowhead violet	7	53
Carex meadii	sedge	5	52
Eleocharis sp.	spikerush		39
Helianthus mollis	ashy sunflower	6	38
Pedicularis canadensis	lousewort	5	38
Koeleria cristata	June grass	6	37
Liatris pycnostachya	blazing star	6	33
Polygala sanguinea	milkwort	5	33
Physotegia angustifolia	false dragonhead	6	31
Tephrosia virginiana	goat's rue	5	30
Penstemon sp.	beardtongue		28
Scleria triglomerata	nut-rush	7	26
Carex abdita	sedge	9	26

## 3. Monitoring results, 1993 - Wilson and Jackson (1994)

Monitoring at Diamond Grove in 1993 was conducted along a perimeter area of the southern portion of the site, and sampling was not as extensive as in 1984. For these reasons, the data will not be used as a species composition model. The following table is a compilation of the highest values of the summer and fall monitoring combined (see the following pages for a full list of monitoring results). Two species from this list, *Andropogon ternarius* and *Dichanthelium latifolium* are included in the restoration model species list due to their high values.

Species		Coefficient of Conservatism	Importance Value
Andropogon scoparius	5		.101
Andropogon ternarius	5		.096
Andropogon virginicus	2		.089
Panicum virgatum	4		.086
Carex, sp.	-		.079
Dichanthelium latifolium	6		.075
Dichanthelium oligosanthos	3		.067
Andropogon gerardii	5		.062
Carex muhlenbergii	5		.048
Erigeron philadelphicus	3		.039

Total species: 109 (grass/sedges=26; woody=7; forbs=76)  
 exotic species: 12

APPENDIX VIII

EXOTIC SPECIES CONTROL METHODS

The following are a set of control plans for exotic species that are a critical threat to the park's resources (based on a combination of the aggressiveness, abundance, and difficulty of control). Plans are taken from the Missouri Vegetation Manual (Smith, 1993).



APPENDIX IX  
CLIMATOLOGICAL SUMMARY

Temperature and precipitation readings have been taken at George Washington Carver sporadically since at least the early seventies. However, the data has not been taken consistently enough to provide sufficient summaries. More useful is data taken from the Soil Survey of Newton County, Missouri (1983), from climatological readings at Neosho, 1952-1980, shown here.

### 1. Temperature

Month	Temperature (F)					
	Avg. daily	Avg. daily	Aver- age	2 years in 10 will have		Avg. growing degree days
	max.	min.		max. temp higher than:	min. temp. lower than:	
JAN	46.0	22.7	34.4	71	-5	19
FEB	51.6	27.2	39.4	76	0	27
MAR	60.3	34.7	47.5	85	7	122
APR	72.4	45.8	59.1	89	23	288
MAY	78.9	54.3	66.6	90	30	515
JUN	86.2	62.7	74.5	96	43	735
JUL	91.3	66.8	79.1	101	48	902
AUG	90.7	64.7	77.7	101	49	859
SEP	83.6	57.7	70.6	96	36	618
OCT	73.8	46.3	60.1	91	24	324
NOV	59.1	35.2	47.2	80	9	69
DEC	49.9	27.5	38.7	72	-2	13

YEARLY:

AVERAGE	70.3	45.5	57.9	-----	-----	-----
EXTREME	-----	---	---	103	-9	-----
TOTAL	-----	---	---	-----	-----	4,491

## 2. Precipitation

Month	Average (in.)	2 years in 10 will have....		Avg. no. days with 0.10 inch or more	Avg. snow- fall (in.)
		less than-in.	more than (inch)...		
JAN	1.51	0.62	2.27	3	3.8
FEB	2.12	1.02	3.06	4	3.0
MAR	3.42	1.63	4.95	6	2.6
APR	4.14	2.45	5.64	7	0
MAY	4.65	2.68	6.40	8	0
JUN	4.82	1.98	7.21	7	0
JUL	3.46	1.18	5.32	5	0
AUG	3.30	1.67	4.71	5	0
SEP	4.45	1.48	6.88	6	0
OCT	3.74	1.06	5.88	5	0
NOV	2.99	.93	4.65	5	1.4
DEC	2.27	1.08	3.29	4	1.4

YEARLY:

TOTAL	40.87	32.72	48.54	65	12.2
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**3. Freeze dates in spring and fall**

Probability	Temperature		
	24°F or lower	28°F or lower	32°F or lower
Last freezing temperature in spring			
1 year in ten later than:	April 9	April 23	May 8
2 years in ten later than:	April 4	April 18	May 2
5 years in ten later than:	March 25	April 8	April 21
First freezing temperature in fall:			
1 year in 10 earlier than:	October 23	October 11	October 3
2 years in 10 earlier than:	October 28	October 16	October 7
5 years in 10 earlier than:	November 8	October 27	October 16

**4. Growing season**

Probability	Daily minimum temperature during growing season		
	Higher than 24°F (days)	Higher than 28°F (days)	Higher than 32°F (days)
9 years in 10	203	179	155

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8 years in 10	211	187	163
5 years in 10	227	201	177
2 years in 10	243	216	192
1 year in 10	251	223	199